Introduction

Importation des library et des donnees

```
# library Importation

import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from geopy.geocoders import Nominatim
import cachetools
from sklearn.impute import SimpleImputer
# Decision Tree
from sklearn.tree import DecisionTreeClassifier, plot_tree, export_text
# Random Forest
from sklearn.ensemble import RandomForestClassifier
# Evaluation metrices
from sklearn.metrics import confusion_matrix, accuracy_score, precision_score, recall_score, f1_score, classification_report, roc_curve,
from sklearn.ensemble import RandomForestClassifier
import warnings
warnings.filterwarnings('ignore')
```

```
# Data frames reading

# Train
df_train = pd.read_csv("/content/train_Insurance.csv")
display (df_train)

# Test
df_test = pd.read_csv("/content/test_Insurance.csv")
display (df_test)
```

	Customer Id	YearOfObservation	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	Settlement	Building Dimension	Bu
0	H13501	2012	1.0	1	N	V	V	U	1240.0	
1	H14962	2012	1.0	0	N	V	V	U	900.0	
2	H17755	2013	1.0	1	V	N	O	R	4984.0	
3	H13369	2016	0.5	0	N	V	V	U	600.0	
4	H12988	2012	1.0	0	N	V	V	U	900.0	
...	...	...	...	...	...	...	...	...	...	
5007	H13682	2013	1.0	0	N	V	V	U	550.0	
5008	H18342	2012	0.5	0	V	N	O	R	1000.0	
5009	H16892	2015	1.0	1	V	N	O	R	480.0	
5010	H18805	2012	0.5	0	V	N	O	R	536.0	
5011	H18228	2013	1.0	1	V	V	V	U	NaN	

5012 rows × 13 columns

	Customer Id	YearOfObservation	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	Settlement	Building Dimension	Bu
0	H3733	2013	1.0	0	V	V	V	U	3760.0	
1	H16909	2015	1.0	0	V	N	O	R	1452.0	
2	H16867	2013	1.0	1	V	N	O	R	1944.0	
3	H14813	2015	1.0	0	N	V	V	U	2270.0	
4	H3728	2016	0.5	0	V	N	O	R	2976.0	
...	...	...	...	...	...	...	...	...	...	
2142	H19924	2016	0.5	1	V	N	O	R	862.0	
2143	H17249	2012	1.0	0	V	V	V	U	NaN	
2144	H18804	2014	1.0	0	V	N	O	R	730.0	
2145	H12650	2014	1.0	1	N	V	V	U	568.0	
2146	H13879	2013	0.5	0	N	V	V	U	730.0	

2147 rows × 13 columns

```
#fonction qui seront etre utilisé plus tard

# Fonction pour le traitement des valeur manquantes
def traitement_des_valeurs_manquantes(df,NomDuColone):
  mf_imputer = SimpleImputer(missing_values=np.nan, strategy='most_frequent')
  df[NomDuColone] = mf_imputer.fit_transform(df[[NomDuColone]])
  return df

# Fonction pourt elimination des outliers
def treatment_des_outliers(df,feature):
  Q1,Q3=np.percentile(df[feature],[25,75])
  IQR=Q3-Q1
  lower_limit=max(Q1 - 1.5 * IQR, df[feature].min()+100)
  # Lower_limit is -2125 building dimension can t be negatif nor close to 0
  upper_limit=Q3+1.5*IQR
  df[feature]=np.where(df[feature]>=upper_limit,
  upper_limit, np.where(df[feature]<=lower_limit,
  lower_limit,df[feature]))
  return df
```

Analyse des Donnees

```
# Column Types
display(df_train.dtypes)
display(df_test.dtypes)
```

	0
Customer Id	object
YearOfObservation	int64
Insured_Period	float64
Residential	int64
Building_Painted	object
Building_Fenced	object
Garden	object
Settlement	object
Building Dimension	float64
Building_Type	object
NumberOfWindows	object
Geo_Code	object
Claim	object

dtype: object

	0
Customer Id	object
YearOfObservation	int64
Insured_Period	float64
Residential	int64
Building_Painted	object
Building_Fenced	object
Garden	object
Settlement	object
Building Dimension	float64
Building_Type	object
NumberOfWindows	object
Geo_Code	object
Claim	object

dtype: object

```
#EDA : Statistique descriptif

display(df_train.describe(include='all')) # (all) Pour les colonnes categorielle aussi
display(df_test.describe(include='all')) # (all) Pour les colonnes categorielle aussi
```

	Customer Id	YearOfObservation	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	Settlement	Building Dimension
count	5012	5012.000000	5012.000000	5012.000000	5012	5012	5008	5012	4935.00000(
unique	5012	NaN	NaN	NaN	2	2	2	2	NaN
top	H13501	NaN	NaN	NaN	V	N	O	R	NaN
freq	1	NaN	NaN	NaN	3763	2535	2532	2537	NaN
mean	NaN	2013.660215	0.869713	0.301077	NaN	NaN	NaN	NaN	1876.89868:
std	NaN	1.383134	0.219496	0.458772	NaN	NaN	NaN	NaN	2267.27739
min	NaN	2012.000000	0.500000	0.000000	NaN	NaN	NaN	NaN	1.00000(
25%	NaN	2012.000000	0.500000	0.000000	NaN	NaN	NaN	NaN	520.00000(
50%	NaN	2013.000000	1.000000	0.000000	NaN	NaN	NaN	NaN	1067.00000(
75%	NaN	2015.000000	1.000000	1.000000	NaN	NaN	NaN	NaN	2280.00000(
max	NaN	2016.000000	1.000000	1.000000	NaN	NaN	NaN	NaN	20840.00000(

	Customer Id	YearOfObservation	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	Settlement	Building Dimension
count	2147	2147.000000	2147.000000	2147.000000	2147	2147	2144	2147	2118.00000(
unique	2147	NaN	NaN	NaN	2	2	2	2	NaN
top	H3733	NaN	NaN	NaN	V	V	V	U	NaN
freq	1	NaN	NaN	NaN	1619	1074	1074	1074	NaN
mean	NaN	2013.691197	0.876805	0.315789	NaN	NaN	NaN	NaN	1899.70018
std	NaN	1.385631	0.215504	0.464938	NaN	NaN	NaN	NaN	2304.30005:
min	NaN	2012.000000	0.500000	0.000000	NaN	NaN	NaN	NaN	10.00000(
25%	NaN	2012.000000	1.000000	0.000000	NaN	NaN	NaN	NaN	535.50000(
50%	NaN	2013.000000	1.000000	0.000000	NaN	NaN	NaN	NaN	1100.00000(
75%	NaN	2015.000000	1.000000	1.000000	NaN	NaN	NaN	NaN	2300.00000(
max	NaN	2016.000000	1.000000	1.000000	NaN	NaN	NaN	NaN	20940.00000(

```
# DF Info

display(df_train.info())
display(df_test.info())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5012 entries, 0 to 5011
Data columns (total 13 columns):
 #   Column              Non-Null Count  Dtype  
---  ------              --------------  -----  
 0   Customer Id         5012 non-null   object 
 1   YearOfObservation   5012 non-null   int64  
 2   Insured_Period      5012 non-null   float64
 3   Residential         5012 non-null   int64  
 4   Building_Painted    5012 non-null   object 
 5   Building_Fenced     5012 non-null   object 
 6   Garden              5008 non-null   object 
 7   Settlement          5012 non-null   object 
 8   Building Dimension  4935 non-null   float64
 9   Building_Type       5012 non-null   object 
 10  NumberOfWindows     5012 non-null   object 
 11  Geo_Code            4939 non-null   object 
 12  Claim               5012 non-null   object 
dtypes: float64(2), int64(2), object(9)
memory usage: 509.2+ KB
None
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2147 entries, 0 to 2146
Data columns (total 13 columns):
 #   Column              Non-Null Count  Dtype  
---  ------              --------------  -----  
 0   Customer Id         2147 non-null   object 
 1   YearOfObservation   2147 non-null   int64  
 2   Insured_Period      2147 non-null   float64
 3   Residential         2147 non-null   int64  
 4   Building_Painted    2147 non-null   object 
 5   Building_Fenced     2147 non-null   object 
 6   Garden              2144 non-null   object 
 7   Settlement          2147 non-null   object 
 8   Building Dimension  2118 non-null   float64
 9   Building_Type       2147 non-null   object 
 10  NumberOfWindows     2147 non-null   object 
 11  Geo_Code            2118 non-null   object 
 12  Claim               2147 non-null   object 
dtypes: float64(2), int64(2), object(9)
memory usage: 218.2+ KB
None
```

```
# Detection des valeurs manquantes

display(df_train.isna().sum())
display(df_test.isna().sum())
```

	0
Customer Id	0
YearOfObservation	0
Insured_Period	0
Residential	0
Building_Painted	0
Building_Fenced	0
Garden	4
Settlement	0
Building Dimension	77
Building_Type	0
NumberOfWindows	0
Geo_Code	73
Claim	0

dtype: int64

	0
Customer Id	0
YearOfObservation	0
Insured_Period	0
Residential	0
Building_Painted	0
Building_Fenced	0
Garden	3
Settlement	0
Building Dimension	29
Building_Type	0
NumberOfWindows	0
Geo_Code	29
Claim	0

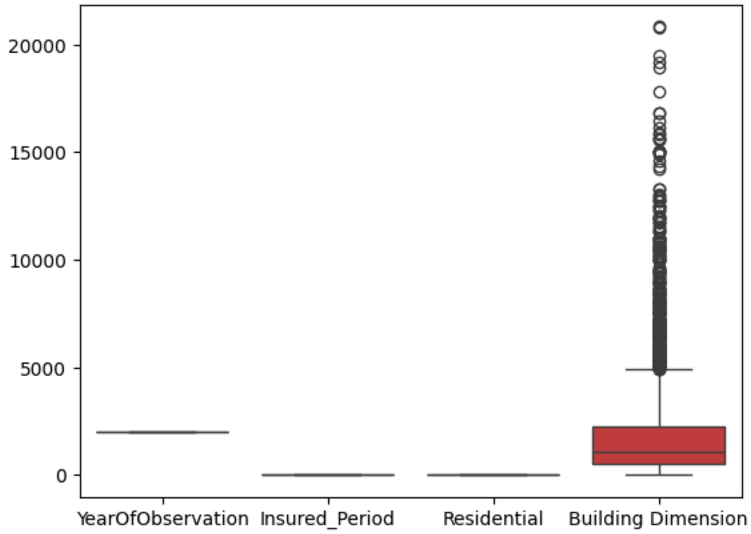
dtype: int64

```
#valeurs tres eloignées

# List of Numerical columns
numerical=list(df_train.select_dtypes(include="number"))
print(numerical)

# Affichage des valeurs tres eloignées
sns.boxplot(data=df_train[numerical])
plt.show()
```

```
['YearOfObservation', 'Insured_Period', 'Residential', 'Building Dimension']
```



Data Preprocessing (Feature By Feature)

Customer Id Feature

```
# Analyse

print("Nomber of None Values = ",df_train['Customer Id'].isna().sum())
display(df_train["Customer Id"].describe())

print("Nomber of None Values = ",df_test['Customer Id'].isna().sum())
display (df_test["Customer Id"].describe())
```

```
Nomber of None Values =  0
```

	Customer Id
count	5012
unique	5012
top	H13501
freq	1

dtype: object

```
Nomber of None Values =  0
```

	Customer Id
count	2147
unique	2147
top	H3733
freq	1

dtype: object

```
# Reduction de Dimension (Useless Feature)

df_train=df_train.drop(columns=["Customer Id"])
df_test=df_test.drop(columns=["Customer Id"])

# Verification
print(df_train.columns)
print(df_test.columns)
```

```
Index(['YearOfObservation', 'Insured_Period', 'Residential',
       'Building_Painted', 'Building_Fenced', 'Garden', 'Settlement',
       'Building Dimension', 'Building_Type', 'NumberOfWindows', 'Geo_Code',
       'Claim'],
      dtype='object')
Index(['YearOfObservation', 'Insured_Period', 'Residential',
       'Building_Painted', 'Building_Fenced', 'Garden', 'Settlement',
       'Building Dimension', 'Building_Type', 'NumberOfWindows', 'Geo_Code',
       'Claim'],
      dtype='object')
```

YearOfObservation

```
# Analyse

print("Nomber of None Values = ",df_train['YearOfObservation'].isna().sum())
display(df_train["YearOfObservation"].describe())

print("Nomber of None Values = ",df_test['YearOfObservation'].isna().sum())
display (df_test["YearOfObservation"].describe())
```

Nomber of None Values = 0

	YearOfObservation
count	5012.000000
mean	2013.660215
std	1.383134
min	2012.000000
25%	2012.000000
50%	2013.000000
75%	2015.000000
max	2016.000000

dtype: float64

Nomber of None Values = 0

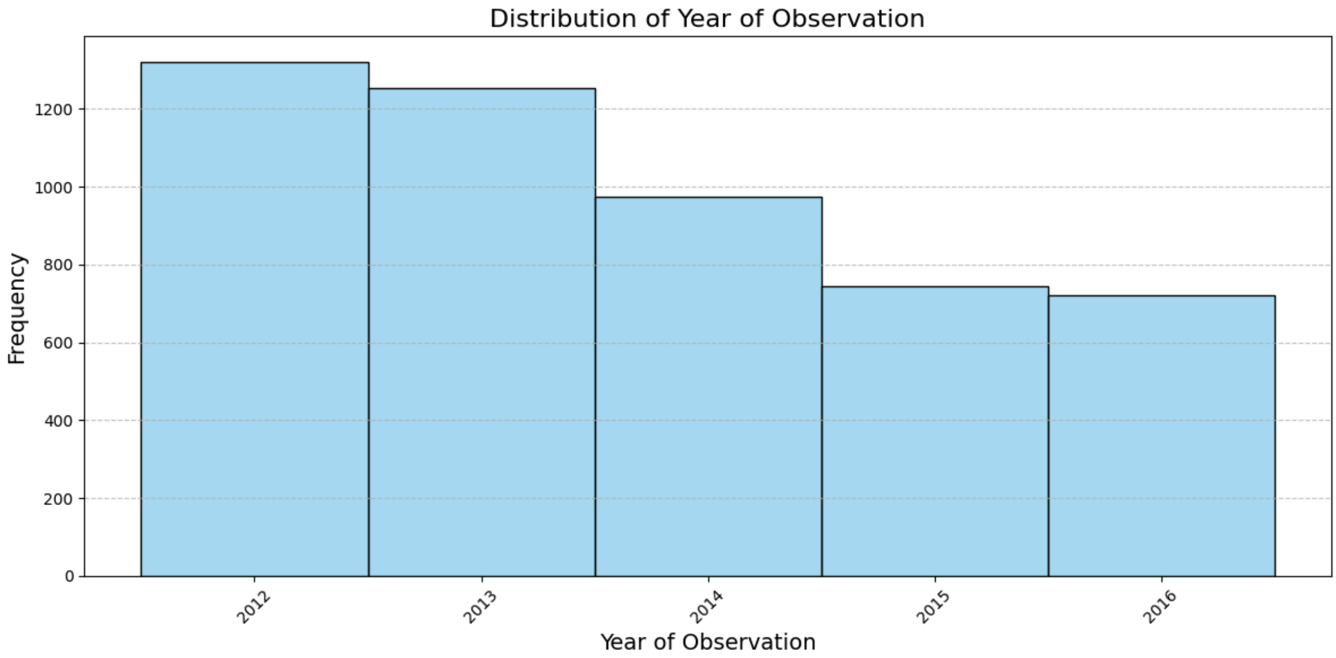
	YearOfObservation
count	2147.000000
mean	2013.691197
std	1.385631
min	2012.000000
25%	2012.000000
50%	2013.000000
75%	2015.000000
max	2016.000000

dtype: float64

```
# Visualisation
unique_years = df_train['YearOfObservation'].unique()
num_bins = len(unique_years)

# Plot histogram with integer bins
plt.figure(figsize=(12, 6))
sns.histplot(
    x="YearOfObservation",
    data=df_train,
    bins=num_bins,
    discrete=True,
    kde=False,  # Add a kernel density estimate curve only if it makes sense
    color="skyblue",  # Use a light color for better aesthetics
    edgecolor="black"  # Add edges for better distinction between bins
)

# Force x-axis ticks to be integers
plt.xticks(
    ticks=range(df_train['YearOfObservation'].min(), df_train['YearOfObservation'].max() + 1),
    rotation=45  # Rotate x-axis labels for better readability if years are close
)
plt.title("Distribution of Year of Observation", fontsize=16)
plt.xlabel("Year of Observation", fontsize=14)
plt.ylabel("Frequency", fontsize=14)
plt.grid(axis='y', linestyle='--', alpha=0.7)  # Add gridlines for visual clarity
plt.tight_layout()  # Ensure layout is not cut off
plt.show()
```




```
# Reduction de Dimension (Useless Feature)
df_train=df_train.drop(columns=["YearOfObservation"])
df_test=df_test.drop(columns=["YearOfObservation"])

# Verification
print(df_train.columns)
print(df_test.columns)
```

```
Index(['Insured_Period', 'Residential', 'Building_Painted', 'Building_Fenced',
       'Garden', 'Settlement', 'Building Dimension', 'Building_Type',
       'NumberOfWindows', 'Geo_Code', 'Claim'],
      dtype='object')
Index(['Insured_Period', 'Residential', 'Building_Painted', 'Building_Fenced',
       'Garden', 'Settlement', 'Building Dimension', 'Building_Type',
       'NumberOfWindows', 'Geo_Code', 'Claim'],
      dtype='object')
```

Insured_Period

```
# Analyse

print("Nomber of None Values = ",df_train['Insured_Period'].isna().sum())
display(df_train["Insured_Period"].describe())

print("Nomber of None Values = ",df_test['Insured_Period'].isna().sum())
display(df_test["Insured_Period"].describe())
```

Nomber of None Values = 0

	Insured_Period
count	5012.000000
mean	0.869713
std	0.219496
min	0.500000
25%	0.500000
50%	1.000000
75%	1.000000
max	1.000000

dtype: float64

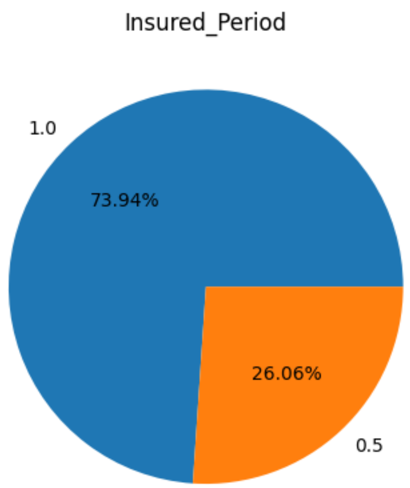
Nomber of None Values = 0

	Insured_Period
count	2147.000000
mean	0.876805
std	0.215504
min	0.500000
25%	1.000000
50%	1.000000
75%	1.000000
max	1.000000

dtype: float64

```
# Visualisation

Insured_Period_counts=df_train['Insured_Period'].value_counts()
labels=list(Insured_Period_counts.index)
df_train['Insured_Period'].value_counts().plot.pie(autopct='%1.2f%%',labels=labels,ylabel="",title='Insured_Period')
plt.show()
```



Residential

```
# Analyse

print("Nomber of None Values = ",df_train['Residential'].isna().sum())
display(df_train["Residential"].describe())

print("Nomber of None Values = ",df_test['Residential'].isna().sum())
display(df_test["Residential"].describe())
```

```
Nomber of None Values =  0
```

	Residential
count	5012.000000
mean	0.301077
std	0.458772
min	0.000000
25%	0.000000
50%	0.000000
75%	1.000000
max	1.000000

dtype: float64

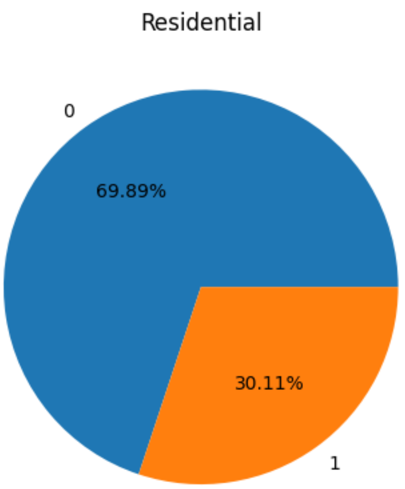
```
Nomber of None Values =  0
```

	Residential
count	2147.000000
mean	0.315789
std	0.464938
min	0.000000
25%	0.000000
50%	0.000000
75%	1.000000
max	1.000000

dtype: float64

```
# Visualisation

Residential_counts=df_train['Residential'].value_counts()
labels=list(Residential_counts.index)
df_train['Residential'].value_counts().plot.pie(autopct='%1.2f%%',ylabel="",labels=labels,title='Residential')
plt.show()
```



Building_Painted

```
# Analyse

print("Nomber of None Values = ",df_train['Building_Painted'].isna().sum())
display(df_train["Building_Painted"].describe())

print("Nomber of None Values = ",df_test['Building_Painted'].isna().sum())
display(df_test["Building_Painted"].describe())
```

```
Nomber of None Values =  0
```

	Building_Painted
count	5012
unique	2
top	V
freq	3763

dtype: object

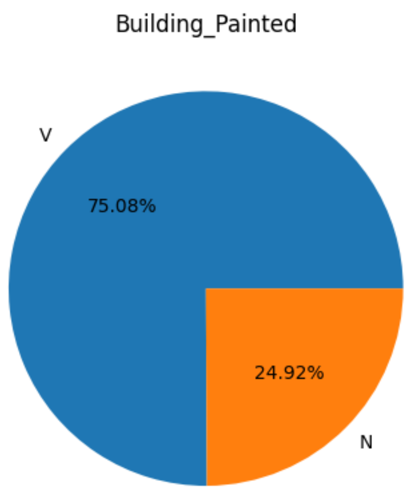
```
Nomber of None Values =  0
```

	Building_Painted
count	2147
unique	2
top	V
freq	1619

dtype: object

```
# Visualisation

Building_Painted_counts=df_train['Building_Painted'].value_counts()
labels=list(Building_Painted_counts.index)
df_train['Building_Painted'].value_counts().plot.pie(autopct='%1.2f%%',ylabel="",labels=labels,title='Building_Painted')
plt.show()
```




```
# Binary Encoding

#(N : oui, V : non)
df_train ["Building_Painted"].replace({"N":1,"V":0},inplace=True)
df_test ["Building_Painted"].replace({"N":1,"V":0},inplace=True)
#(1 : oui, 0 : non)
display(df_train)
display(df_test)
```

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	Settlement	Building Dimension	Building_Type	NumberOfWindows
0	1.0	1	1	V	V	U	1240.0	Wood-framed	without
1	1.0	0	1	V	V	U	900.0	Non-combustible	without
2	1.0	1	0	N	O	R	4984.0	Non-combustible	4
3	0.5	0	1	V	V	U	600.0	Wood-framed	without
4	1.0	0	1	V	V	U	900.0	Non-combustible	without
...	...	...	...	...	...	...	...	...	...
5007	1.0	0	1	V	V	U	550.0	Ordinary	without
5008	0.5	0	0	N	O	R	1000.0	Fire-resistive	4
5009	1.0	1	0	N	O	R	480.0	Ordinary	3
5010	0.5	0	0	N	O	R	536.0	Fire-resistive	4
5011	1.0	1	0	V	V	U	NaN	Wood-framed	without

5012 rows × 11 columns

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	Settlement	Building Dimension	Building_Type	NumberOfWindows
0	1.0	0	0	V	V	U	3760.0	Fire-resistive	without
1	1.0	0	0	N	O	R	1452.0	Fire-resistive	5
2	1.0	1	0	N	O	R	1944.0	Ordinary	6
3	1.0	0	1	V	V	U	2270.0	Non-combustible	without
4	0.5	0	0	N	O	R	2976.0	Fire-resistive	9
...	...	...	...	...	...	...	...	...	...
2142	0.5	1	0	N	O	R	862.0	Wood-framed	2
2143	1.0	0	0	V	V	U	NaN	Non-combustible	without

Building_Fenced

```
# Analyse

print("Nomber of None Values = ",df_train['Building_Fenced'].isna().sum())
display(df_train["Building_Fenced"].describe())

print("Nomber of None Values = ",df_test['Building_Fenced'].isna().sum())
display(df_test["Building_Fenced"].describe())
```

Nomber of None Values = 0

	Building_Fenced
count	5012
unique	2
top	N
freq	2535

dtype: object

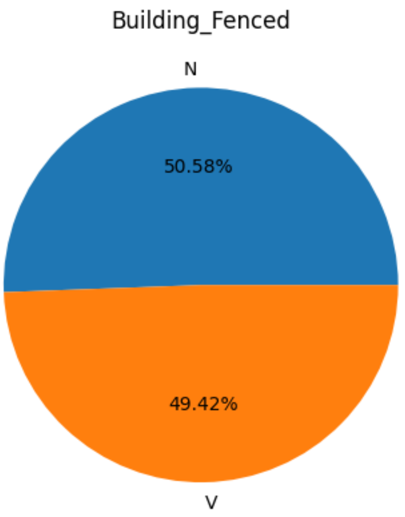
Nomber of None Values = 0

	Building_Fenced
count	2147
unique	2
top	V
freq	1074

dtype: object

```
# Visualisation
```

```
Building_Fenced_counts=df_train['Building_Fenced'].value_counts()
labels=list(Building_Fenced_counts.index)
df_train['Building_Fenced'].value_counts().plot.pie(autopct='%1.2f%%',ylabel="",labels=labels,title='Building_Fenced')
plt.show()
```




```
# Binary Encoding

#(N : oui, V : non)
df_train ["Building_Fenced"].replace({"N":1,"V":0},inplace=True)
df_test ["Building_Fenced"].replace({"N":1,"V":0},inplace=True)
#(1 : oui, 0 : non)
display(df_train)
display(df_test)
```

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	Settlement	Building Dimension	Building_Type	NumberOfWindows
0	1.0	1	1	0	V	U	1240.0	Wood-framed	without
1	1.0	0	1	0	V	U	900.0	Non-combustible	without
2	1.0	1	0	1	O	R	4984.0	Non-combustible	4
3	0.5	0	1	0	V	U	600.0	Wood-framed	without
4	1.0	0	1	0	V	U	900.0	Non-combustible	without
...	...	...	...	...	...	...	...	...	...
5007	1.0	0	1	0	V	U	550.0	Ordinary	without
5008	0.5	0	0	1	O	R	1000.0	Fire-resistive	4
5009	1.0	1	0	1	O	R	480.0	Ordinary	3
5010	0.5	0	0	1	O	R	536.0	Fire-resistive	4
5011	1.0	1	0	0	V	U	NaN	Wood-framed	without

5012 rows × 11 columns

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	Settlement	Building Dimension	Building_Type	NumberOfWindows
0	1.0	0	0	0	V	U	3760.0	Fire-resistive	without
1	1.0	0	0	1	O	R	1452.0	Fire-resistive	5
2	1.0	1	0	1	O	R	1944.0	Ordinary	6
3	1.0	0	1	0	V	U	2270.0	Non-combustible	without
4	0.5	0	0	1	O	R	2976.0	Fire-resistive	9
...	...	...	...	...	...	...	...	...	...
2142	0.5	1	0	1	O	R	862.0	Wood-framed	2
2143	1.0	0	0	0	V	U	NaN	Non-combustible	without

Garden

```
# Analyse

print("Nomber of None Values = ",df_train['Garden'].isna().sum())
display(df_train["Garden"].describe())

print("Nomber of None Values = ",df_test['Garden'].isna().sum())
display(df_test["Garden"].describe())
```

```
Nomber of None Values =  4
```

	Garden
count	5008
unique	2
top	O
freq	2532

dtype: object

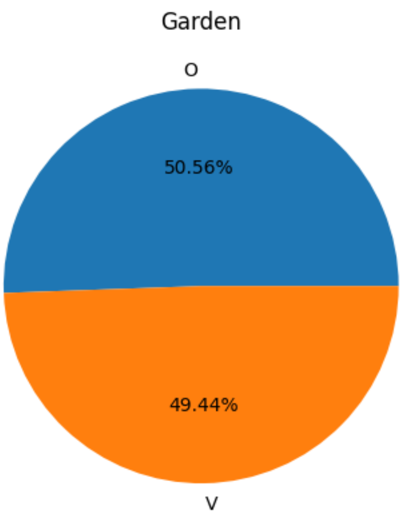
```
Nomber of None Values =  3
```

	Garden
count	2144
unique	2
top	V
freq	1074

dtype: object

```
# Visualisation

Garden_counts=df_train['Garden'].value_counts()
labels=list(Garden_counts.index)
df_train['Garden'].value_counts().plot.pie(autopct='%1.2f%%',ylabel="",labels=labels,title='Garden')
plt.show()
```




```
# Binary Encoding

#(V : oui, O : non)
df_train ["Garden"].replace({"V":1,"O":0},inplace=True)
df_test ["Garden"].replace({"V":1,"O":0},inplace=True)
#(1 : oui, 0 : non)

display(df_train)
display(df_test)
```

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	Settlement	Building Dimension	Building_Type	NumberOfWindows
0	1.0	1	1	0	1.0	U	1240.0	Wood-framed	without
1	1.0	0	1	0	1.0	U	900.0	Non-combustible	without
2	1.0	1	0	1	0.0	R	4984.0	Non-combustible	4
3	0.5	0	1	0	1.0	U	600.0	Wood-framed	without
4	1.0	0	1	0	1.0	U	900.0	Non-combustible	without
...	...	...	...	...	...	...	...	...	...
5007	1.0	0	1	0	1.0	U	550.0	Ordinary	without
5008	0.5	0	0	1	0.0	R	1000.0	Fire-resistive	4
5009	1.0	1	0	1	0.0	R	480.0	Ordinary	3
5010	0.5	0	0	1	0.0	R	536.0	Fire-resistive	4
5011	1.0	1	0	0	1.0	U	NaN	Wood-framed	without

5012 rows × 11 columns

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	Settlement	Building Dimension	Building_Type	NumberOfWindows
0	1.0	0	0	0	1.0	U	3760.0	Fire-resistive	without
1	1.0	0	0	1	0.0	R	1452.0	Fire-resistive	5
2	1.0	1	0	1	0.0	R	1944.0	Ordinary	6
3	1.0	0	1	0	1.0	U	2270.0	Non-combustible	without
4	0.5	0	0	1	0.0	R	2976.0	Fire-resistive	9
...	...	...	...	...	...	...	...	...	...
2142	0.5	1	0	1	0.0	R	862.0	Wood-framed	2
2143	1.0	0	0	0	1.0	U	NaN	Non-combustible	without

```
# traitement des valeur manquantes

df_train.dropna(subset=["Garden"], inplace=True)
display ( df_train)

df_test.dropna(subset=["Garden"], inplace=True)
display ( df_test)
```

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	Settlement	Building Dimension	Building_Type	NumberOfWindows
0	1.0	1	1	0	1.0	U	1240.0	Wood-framed	without
1	1.0	0	1	0	1.0	U	900.0	Non-combustible	without
2	1.0	1	0	1	0.0	R	4984.0	Non-combustible	4
3	0.5	0	1	0	1.0	U	600.0	Wood-framed	without
4	1.0	0	1	0	1.0	U	900.0	Non-combustible	without
...	...	...	...	...	...	...	...	...	...
5007	1.0	0	1	0	1.0	U	550.0	Ordinary	without
5008	0.5	0	0	1	0.0	R	1000.0	Fire-resistive	4
5009	1.0	1	0	1	0.0	R	480.0	Ordinary	3
5010	0.5	0	0	1	0.0	R	536.0	Fire-resistive	4
5011	1.0	1	0	0	1.0	U	NaN	Wood-framed	without

5008 rows × 11 columns

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	Settlement	Building Dimension	Building_Type	NumberOfWindows
0	1.0	0	0	0	1.0	U	3760.0	Fire-resistive	without
1	1.0	0	0	1	0.0	R	1452.0	Fire-resistive	5
2	1.0	1	0	1	0.0	R	1944.0	Ordinary	6
3	1.0	0	1	0	1.0	U	2270.0	Non-combustible	without
4	0.5	0	0	1	0.0	R	2976.0	Fire-resistive	9
...	...	...	...	...	...	...	...	...	...
2142	0.5	1	0	1	0.0	R	862.0	Wood-framed	2
2143	1.0	0	0	0	1.0	U	NaN	Non-combustible	without

```
#Astype

df_train ["Garden"] = df_train["Garden"].astype('int64')
df_test ["Garden"] = df_test["Garden"].astype('int64')

display(df_train)
display(df_test)
```

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	Settlement	Building Dimension	Building_Type	NumberOfWindows
0	1.0	1	1	0	1	U	1240.0	Wood-framed	without
1	1.0	0	1	0	1	U	900.0	Non-combustible	without
2	1.0	1	0	1	0	R	4984.0	Non-combustible	4
3	0.5	0	1	0	1	U	600.0	Wood-framed	without
4	1.0	0	1	0	1	U	900.0	Non-combustible	without
...	...	...	...	...	...	...	...	...	...
5007	1.0	0	1	0	1	U	550.0	Ordinary	without
5008	0.5	0	0	1	0	R	1000.0	Fire-resistive	4
5009	1.0	1	0	1	0	R	480.0	Ordinary	3
5010	0.5	0	0	1	0	R	536.0	Fire-resistive	4
5011	1.0	1	0	0	1	U	NaN	Wood-framed	without

5008 rows × 11 columns

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	Settlement	Building Dimension	Building_Type	NumberOfWindows
0	1.0	0	0	0	1	U	3760.0	Fire-resistive	without
1	1.0	0	0	1	0	R	1452.0	Fire-resistive	5
2	1.0	1	0	1	0	R	1944.0	Ordinary	6
3	1.0	0	1	0	1	U	2270.0	Non-combustible	without
4	0.5	0	0	1	0	R	2976.0	Fire-resistive	9
...	...	...	...	...	...	...	...	...	...
2142	0.5	1	0	1	0	R	862.0	Wood-framed	2
2143	1.0	0	0	0	1	U	NaN	Non-combustible	without

Settlement (urbain_zone)

```
# Analyse

print("Nomber of None Values = ",df_train['Settlement'].isna().sum())
display (df_train["Settlement"].describe())

print("Nomber of None Values = ",df_test['Settlement'].isna().sum())
display (df_test["Settlement"].describe())
```

```
Nomber of None Values =  0
```

	Settlement
count	5008
unique	2
top	R
freq	2533

dtype: object

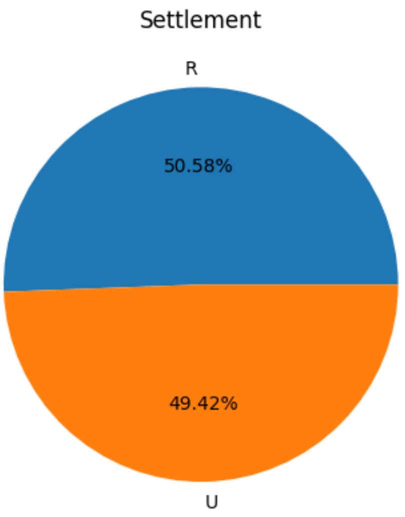
```
Nomber of None Values =  0
```

	Settlement
count	2144
unique	2
top	U
freq	1074

dtype: object

```
# Visualisation
Settlement_counts=df_train['Settlement'].value_counts()
```

```
labels=list(Settlement_counts.index)
df_train['Settlement'].value_counts().plot.pie(autopct='%1.2f%%',ylabel="",labels=labels,title='Settlement')
plt.show()
```




```
# Binary Encoding

#(R : zone rurale, U : zone urbain)
df_train ["Settlement"].replace({"U":1,"R":0},inplace=True)
df_test ["Settlement"].replace({"U":1,"R":0},inplace=True)
#(1 : zone urbain , 0 : zone rurale)
df_train = df_train.rename(columns={'Settlement': 'urbain_zone'})
df_test = df_test.rename(columns={'Settlement': 'urbain_zone'})
display(df_train)
display(df_test)
```

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Building Dimension	Building_Type	NumberOfWindows
0	1.0	1	1	0	1	1	1240.0	Wood-framed	without
1	1.0	0	1	0	1	1	900.0	Non-combustible	without
2	1.0	1	0	1	0	0	4984.0	Non-combustible	4
3	0.5	0	1	0	1	1	600.0	Wood-framed	without
4	1.0	0	1	0	1	1	900.0	Non-combustible	without
...	...	...	...	...	...	...	...	...	...
5007	1.0	0	1	0	1	1	550.0	Ordinary	without
5008	0.5	0	0	1	0	0	1000.0	Fire-resistive	4
5009	1.0	1	0	1	0	0	480.0	Ordinary	3
5010	0.5	0	0	1	0	0	536.0	Fire-resistive	4
5011	1.0	1	0	0	1	1	NaN	Wood-framed	without

5008 rows × 11 columns

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Building Dimension	Building_Type	NumberOfWindows
0	1.0	0	0	0	1	1	3760.0	Fire-resistive	without
1	1.0	0	0	1	0	0	1452.0	Fire-resistive	5
2	1.0	1	0	1	0	0	1944.0	Ordinary	6
3	1.0	0	1	0	1	1	2270.0	Non-combustible	without
4	0.5	0	0	1	0	0	2976.0	Fire-resistive	9
...	...	...	...	...	...	...	...	...	...
2142	0.5	1	0	1	0	0	862.0	Wood-framed	2
2143	1.0	0	0	0	1	1	NaN	Non-combustible	without

Building Dimension

```
# Analyse

print("Nomber of None Values = ",df_train['Building Dimension'].isna().sum())
display (df_train["Building Dimension"].describe())

print("Nomber of None Values = ",df_test['Building Dimension'].isna().sum())
display (df_test["Building Dimension"].describe())
```

```
Nomber of None Values =  77
```

	Building Dimension
count	4931.000000
mean	1876.147232
std	2267.016703
min	1.000000
25%	520.000000
50%	1067.000000
75%	2280.000000
max	20840.000000

dtype: float64

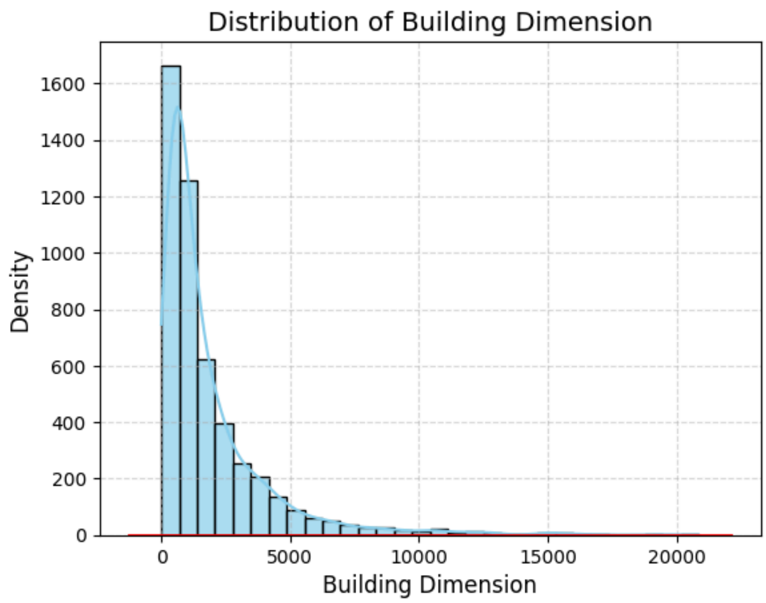
```
Nomber of None Values =  29
```

	Building Dimension
count	2115.000000
mean	1896.437352
std	2301.002647
min	10.000000
25%	536.000000
50%	1100.000000
75%	2296.000000
max	20940.000000

dtype: float64

```
# Visualisation

sns.histplot(df_train['Building Dimension'], kde=True, bins=30, color='skyblue', edgecolor='black', alpha=0.7)
sns.kdeplot(df_train['Building Dimension'], bw_method='scott', bw_adjust=1, color='red', linewidth=2)
plt.title("Distribution of Building Dimension", fontsize=14)
plt.xlabel("Building Dimension", fontsize=12)
plt.ylabel("Density", fontsize=12)
plt.grid(visible=True, linestyle='--', alpha=0.5)
plt.show()
```




```
# traitement des valeur manquantes

df_train = traitement_des_valeurs_manquantes(df_train,'Building Dimension')
display ( df_train)

df_test = traitement_des_valeurs_manquantes(df_test,'Building Dimension')
display ( df_test)
```

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Building Dimension	Building_Type	NumberOfWindows
0	1.0	1	1	0	1	1	1240.0	Wood-framed	without
1	1.0	0	1	0	1	1	900.0	Non-combustible	without
2	1.0	1	0	1	0	0	4984.0	Non-combustible	4
3	0.5	0	1	0	1	1	600.0	Wood-framed	without
4	1.0	0	1	0	1	1	900.0	Non-combustible	without
...	...	...	...	...	...	...	...	...	...
5007	1.0	0	1	0	1	1	550.0	Ordinary	without
5008	0.5	0	0	1	0	0	1000.0	Fire-resistive	4
5009	1.0	1	0	1	0	0	480.0	Ordinary	3
5010	0.5	0	0	1	0	0	536.0	Fire-resistive	4
5011	1.0	1	0	0	1	1	400.0	Wood-framed	without

5008 rows × 11 columns

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Building Dimension	Building_Type	NumberOfWindows
0	1.0	0	0	0	1	1	3760.0	Fire-resistive	without
1	1.0	0	0	1	0	0	1452.0	Fire-resistive	5
2	1.0	1	0	1	0	0	1944.0	Ordinary	6
3	1.0	0	1	0	1	1	2270.0	Non-combustible	without
4	0.5	0	0	1	0	0	2976.0	Fire-resistive	9
...	...	...	...	...	...	...	...	...	...
2142	0.5	1	0	1	0	0	862.0	Wood-framed	2
2143	1.0	0	0	0	1	1	400.0	Non-combustible	without

```
# outliers

df_train=treatment_des_outliers(df_train,"Building Dimension")
display ( df_train)
```

```
df_test=treatment_des_outliers(df_test,"Building Dimension")
display ( df_test)
```

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Building Dimension	Building_Type	NumberOfWindows
0	1.0	1	1	0	1	1	1240.0	Wood-framed	without
1	1.0	0	1	0	1	1	900.0	Non-combustible	without
2	1.0	1	0	1	0	0	4875.0	Non-combustible	4
3	0.5	0	1	0	1	1	600.0	Wood-framed	without
4	1.0	0	1	0	1	1	900.0	Non-combustible	without
...	...	...	...	...	...	...	...	...	...
5007	1.0	0	1	0	1	1	550.0	Ordinary	without
5008	0.5	0	0	1	0	0	1000.0	Fire-resistive	4
5009	1.0	1	0	1	0	0	480.0	Ordinary	3
5010	0.5	0	0	1	0	0	536.0	Fire-resistive	4
5011	1.0	1	0	0	1	1	400.0	Wood-framed	without

5008 rows × 11 columns

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Building Dimension	Building_Type	NumberOfWindows
0	1.0	0	0	0	1	1	3760.0	Fire-resistive	without
1	1.0	0	0	1	0	0	1452.0	Fire-resistive	5
2	1.0	1	0	1	0	0	1944.0	Ordinary	6
3	1.0	0	1	0	1	1	2270.0	Non-combustible	without
4	0.5	0	0	1	0	0	2976.0	Fire-resistive	9
...	...	...	...	...	...	...	...	...	...
2142	0.5	1	0	1	0	0	862.0	Wood-framed	2
2143	1.0	0	0	0	1	1	400.0	Non-combustible	without

```
# Verification

print("Nomber of None Values = ",df_train['Building Dimension'].isna().sum())
display (df_train["Building Dimension"].describe())
print("Nomber of None Values = ",df_test['Building Dimension'].isna().sum())
display (df_test["Building Dimension"].describe())

sns.histplot(df_train['Building Dimension'], kde=True, bins=30, color='skyblue', edgecolor='black', alpha=0.7)
sns.kdeplot(df_train['Building Dimension'], bw_method='scott', bw_adjust=1, color='red', linewidth=2)
plt.title("Distribution of Building Dimension", fontsize=14)
plt.xlabel("Building Dimension", fontsize=12)
plt.ylabel("Density", fontsize=12)
plt.grid(visible=True, linestyle='--', alpha=0.5)
plt.show()
```

```
Nomber of None Values =  0
```

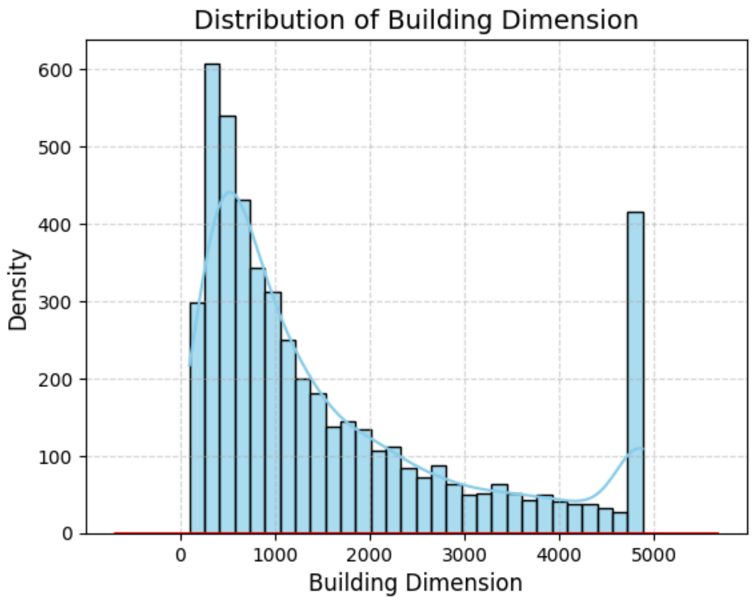
	Building Dimension
count	5008.000000
mean	1611.475040
std	1428.627826
min	101.000000
25%	500.000000
50%	1037.500000
75%	2250.000000
max	4875.000000

dtype: float64

```
Nomber of None Values =  0
```

	Building Dimension
count	2144.000000
mean	1630.354594
std	1426.733205
min	110.000000
25%	514.500000
50%	1069.000000
75%	2263.250000
max	4886.375000

dtype: float64



```
# Binary Encoding

#Summary of the central tendency, dispersion, and shape of a dataset's distribution.
print(df_train["Building Dimension"].describe())
#The 33th percentile (first Tertiles)
Q1 = df_train['Building Dimension'].quantile(0.33)
#The 66th percentile (Second Tertiles)
Q2 = df_train['Building Dimension'].quantile(0.66)
print (Q1,Q2)

df_train["Small_Building"]=np.where(df_train['Building Dimension']<=Q1 , 1 , 0)
df_train["Medium_Building"]=np.where((df_train['Building Dimension']>=Q1 )&(df_train['Building Dimension']<=Q2), 1 , 0)
df_train["Large_Building"]=np.where(df_train['Building Dimension']>=Q2 , 1 , 0)
df_train=df_train.iloc[:, [0,1,2,3,4,5,11,12,13,7,8,9,10,]]
display (df_train)

df_test["Small_Building"]=np.where(df_test['Building Dimension']<=Q1 , 1 , 0)
df_test["Medium_Building"]=np.where((df_test['Building Dimension']>=Q1 )&(df_test['Building Dimension']<=Q2), 1 , 0)
df_test["Large_Building"]=np.where(df_test['Building Dimension']>=Q2 , 1 , 0)
df_test=df_test.iloc[:, [0,1,2,3,4,5,11,12,13,7,8,9,10,]]
display (df_test)
```

```
count    5008.000000
mean     1611.475040
std      1428.627826
min       101.000000
25%       500.000000
50%      1037.500000
75%      2250.000000
max      4875.000000
Name: Building Dimension, dtype: float64
650.0 1699.2400000000007
```

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Small_Building	Medium_Building	Large_Bu
0	1.0	1	1	0	1	1	0	1	
1	1.0	0	1	0	1	1	0	1	
2	1.0	1	0	1	0	0	0	0	
3	0.5	0	1	0	1	1	1	0	
4	1.0	0	1	0	1	1	0	1	
...	...	...	...	...	...	...	...	...	
5007	1.0	0	1	0	1	1	1	0	
5008	0.5	0	0	1	0	0	0	1	
5009	1.0	1	0	1	0	0	1	0	
5010	0.5	0	0	1	0	0	1	0	
5011	1.0	1	0	0	1	1	1	0	

5008 rows × 13 columns

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Small_Building	Medium_Building	Large_Bu
0	1.0	0	0	0	1	1	0	0	
1	1.0	0	0	1	0	0	0	1	
2	1.0	1	0	1	0	0	0	0	
3	1.0	0	1	0	1	1	0	0	
4	0.5	0	0	1	0	0	0	0	
...	...	...	...	...	...	...	...	...	
2142	0.5	1	0	1	0	0	0	1	
2143	1.0	0	0	0	1	1	1	0	
2144	1.0	0	0	1	0	0	0	1	
2145	1.0	1	1	0	1	1	1	0	
2146	0.5	0	1	0	1	1	0	1	

2144 rows × 13 columns

Building_Type

```
# Analyse

print("Nomber of None Values = ",df_train['Building_Type'].isna().sum())
display (df_train["Building_Type"].describe())

print("Nomber of None Values = ",df_test['Building_Type'].isna().sum())
display (df_test["Building_Type"].describe())
```

Nomber of None Values = 0

	Building_Type
count	5008
unique	4
top	Non-combustible
freq	2310

dtype: object

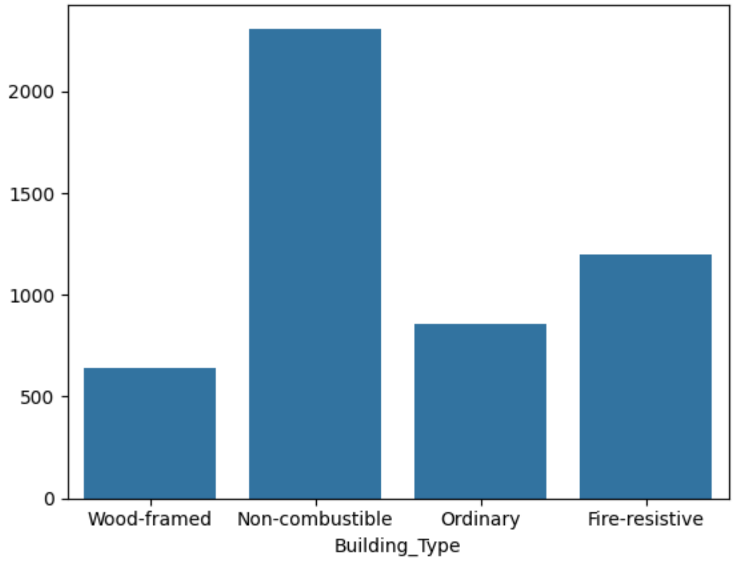
Nomber of None Values = 0

	Building_Type
count	2144
unique	4
top	Non-combustible
freq	995

dtype: object

```
# Visualisation

sns.countplot(x="Building_Type", data=df_train)
plt.ylabel("")
plt.show()
```




```
# Binary Encoding

df_train=pd.get_dummies(df_train, columns=["Building_Type"],prefix="Building_Type", prefix_sep="_", dtype="int64")
df_train=df_train.iloc[:, [0,1,2,3,4,5,6,7,8,12,13,14,15,9,10,11]]
display (df_train)

df_test=pd.get_dummies(df_test, columns=["Building_Type"],prefix="Building_Type", prefix_sep="_", dtype="int64")
df_test=df_test.iloc[:, [0,1,2,3,4,5,6,7,8,12,13,14,15,9,10,11]]
display (df_test)
```

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Small_Building	Medium_Building	Large_Bu
0	1.0	1	1	0	1	1	0	1	
1	1.0	0	1	0	1	1	0	1	
2	1.0	1	0	1	0	0	0	0	
3	0.5	0	1	0	1	1	1	0	
4	1.0	0	1	0	1	1	0	1	
...	...	...	...	...	...	...	...	...	
5007	1.0	0	1	0	1	1	1	0	
5008	0.5	0	0	1	0	0	0	1	
5009	1.0	1	0	1	0	0	1	0	
5010	0.5	0	0	1	0	0	1	0	
5011	1.0	1	0	0	1	1	1	0	

5008 rows × 16 columns

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Small_Building	Medium_Building	Large_Bu
0	1.0	0	0	0	1	1	0	0	
1	1.0	0	0	1	0	0	0	1	
2	1.0	1	0	1	0	0	0	0	
3	1.0	0	1	0	1	1	0	0	
4	0.5	0	0	1	0	0	0	0	
...	...	...	...	...	...	...	...	...	
2142	0.5	1	0	1	0	0	0	1	
2143	1.0	0	0	0	1	1	1	0	
2144	1.0	0	0	1	0	0	0	1	
2145	1.0	1	1	0	1	1	1	0	
2146	0.5	0	1	0	1	1	0	1	

2144 rows × 16 columns

NumberOfWindows

```
# Analyse

print("Nomber of None Values = ",df_train['NumberOfWindows'].isna().sum())
display(df_train["NumberOfWindows"].describe())

print("Nomber of None Values = ",df_test['NumberOfWindows'].isna().sum())
display(df_test["NumberOfWindows"].describe())
```

```
Nomber of None Values =  0
```

	NumberOfWindows
count	5008
unique	11
top	without
freq	2476

dtype: object

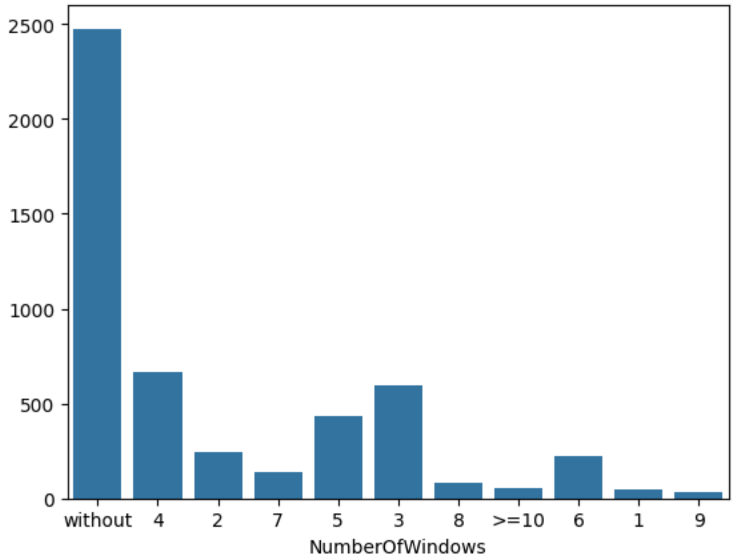
```
Nomber of None Values =  0
```

	NumberOfWindows
count	2144
unique	11
top	without
freq	1074

dtype: object

```
# Visualisation

sns.countplot(x="NumberOfWindows", data=df_train)
plt.ylabel("")
plt.show()
```




```
# Outliers

df_train["NumberOfWindows"].replace({'>=10':10},inplace=True)
display ( df_train)

df_test["NumberOfWindows"].replace({'>=10':10},inplace=True)
display ( df_test)
```

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Small_Building	Medium_Building	Large_Bu
0	1.0	1	1	0	1	1	0	1	
1	1.0	0	1	0	1	1	0	1	
2	1.0	1	0	1	0	0	0	0	
3	0.5	0	1	0	1	1	1	0	
4	1.0	0	1	0	1	1	0	1	
...	...	...	...	...	...	...	...	...	
5007	1.0	0	1	0	1	1	1	0	
5008	0.5	0	0	1	0	0	0	1	
5009	1.0	1	0	1	0	0	1	0	
5010	0.5	0	0	1	0	0	1	0	
5011	1.0	1	0	0	1	1	1	0	

5008 rows × 16 columns

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Small_Building	Medium_Building	Large_Bu
0	1.0	0	0	0	1	1	0	0	
1	1.0	0	0	1	0	0	0	1	
2	1.0	1	0	1	0	0	0	0	
3	1.0	0	1	0	1	1	0	0	
4	0.5	0	0	1	0	0	0	0	
...	...	...	...	...	...	...	...	...	
2142	0.5	1	0	1	0	0	0	1	
2143	1.0	0	0	0	1	1	1	0	
2144	1.0	0	0	1	0	0	0	1	
2145	1.0	1	1	0	1	1	1	0	
2146	0.5	0	1	0	1	1	0	1	

2144 rows × 16 columns

```
# Binary Encoding

#(without dans le cas de 0 fenêtre)
df_train["NumberOfWindows"].replace({"without":0},inplace=True)
df_train['NumberOfWindows'] = pd.to_numeric(df_train['NumberOfWindows']).astype('int64')
#(0 dans le cas de 0 fenêtre)
display (df_train)

#(without dans le cas de 0 fenêtre)
df_test["NumberOfWindows"].replace({"without":0},inplace=True)
df_test['NumberOfWindows'] = pd.to_numeric(df_test['NumberOfWindows']).astype('int64')
#(0 dans le cas de 0 fenêtre)
display (df_test)
```

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Small_Building	Medium_Building	Large_Bu
0	1.0	1	1	0	1	1	0	1	
1	1.0	0	1	0	1	1	0	1	
2	1.0	1	0	1	0	0	0	0	
3	0.5	0	1	0	1	1	1	0	
4	1.0	0	1	0	1	1	0	1	
...	...	...	...	...	...	...	...	...	
5007	1.0	0	1	0	1	1	1	0	
5008	0.5	0	0	1	0	0	0	1	
5009	1.0	1	0	1	0	0	1	0	
5010	0.5	0	0	1	0	0	1	0	
5011	1.0	1	0	0	1	1	1	0	

5008 rows × 16 columns

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Small_Building	Medium_Building	Large_Bu
0	1.0	0	0	0	1	1	0	0	
1	1.0	0	0	1	0	0	0	1	
2	1.0	1	0	1	0	0	0	0	
3	1.0	0	1	0	1	1	0	0	
4	0.5	0	0	1	0	0	0	0	
...	...	...	...	...	...	...	...	...	
2142	0.5	1	0	1	0	0	0	1	
2143	1.0	0	0	0	1	1	1	0	
2144	1.0	0	0	1	0	0	0	1	
2145	1.0	1	1	0	1	1	1	0	
2146	0.5	0	1	0	1	1	0	1	

2144 rows × 16 columns

```
# verification

print("Nomber of None Values = ",df_train['NumberOfWindows'].isna().sum())
display(df_train["NumberOfWindows"].describe())
print("Nomber of None Values = ",df_test['NumberOfWindows'].isna().sum())
display(df_test["NumberOfWindows"].describe())

sns.countplot(x="NumberOfWindows", data=df_train)
plt.ylabel("")
plt.show()
```

```
Nomber of None Values =  0
```

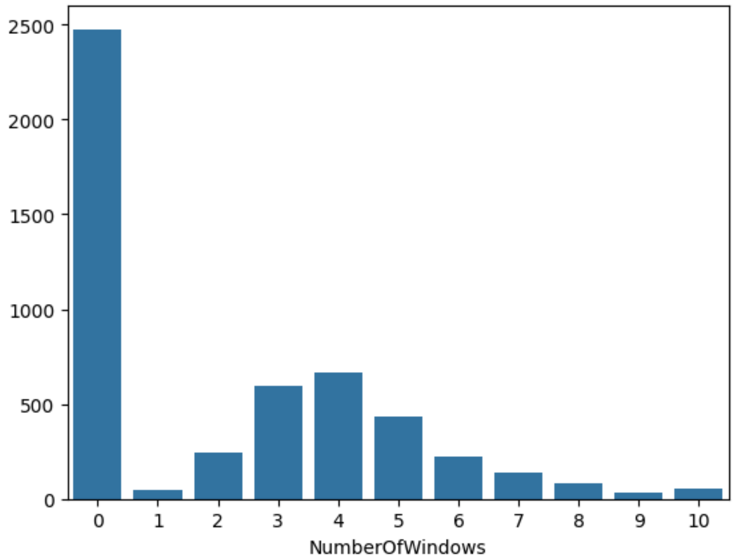
	NumberOfWindows
count	5008.000000
mean	2.202676
std	2.535834
min	0.000000
25%	0.000000
50%	1.000000
75%	4.000000
max	10.000000

dtype: float64

```
Nomber of None Values =  0
```

	NumberOfWindows
count	2144.000000
mean	2.134795
std	2.480540
min	0.000000
25%	0.000000
50%	0.000000
75%	4.000000
max	10.000000

dtype: float64



Geo_Code

```
# Analyse

print("Nomber of None Values = ",df_train['Geo_Code'].isna().sum())
display(df_train["Geo_Code"].describe())

print("Nomber of None Values = ",df_test['Geo_Code'].isna().sum())
display(df_test["Geo_Code"].describe())
```

```
Nomber of None Values =  73
```

	Geo_Code
count	4935
unique	1115
top	6088
freq	102

dtype: object

```
Nomber of None Values =  29
```

	Geo_Code
count	2115
unique	713
top	6088
freq	41

dtype: object

```
# Visualisation
```

```
# Remove Nan values

#most_frequent
df_train['Geo_Code'].ffill(inplace=True)
display(df_train)

df_test['Geo_Code'].ffill(inplace=True)
display(df_test)
```

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Small_Building	Medium_Building	Large_Bu
0	1.0	1	1	0	1	1	0	1	
1	1.0	0	1	0	1	1	0	1	
2	1.0	1	0	1	0	0	0	0	
3	0.5	0	1	0	1	1	1	0	
4	1.0	0	1	0	1	1	0	1	
...	...	...	...	...	...	...	...	...	
5007	1.0	0	1	0	1	1	1	0	
5008	0.5	0	0	1	0	0	0	1	
5009	1.0	1	0	1	0	0	1	0	
5010	0.5	0	0	1	0	0	1	0	
5011	1.0	1	0	0	1	1	1	0	

5008 rows × 16 columns

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Small_Building	Medium_Building	Large_Bu
0	1.0	0	0	0	1	1	0	0	
1	1.0	0	0	1	0	0	0	1	
2	1.0	1	0	1	0	0	0	0	
3	1.0	0	1	0	1	1	0	0	
4	0.5	0	0	1	0	0	0	0	
...	...	...	...	...	...	...	...	...	
2142	0.5	1	0	1	0	0	0	1	
2143	1.0	0	0	0	1	1	1	0	
2144	1.0	0	0	1	0	0	0	1	
2145	1.0	1	1	0	1	1	1	0	
2146	0.5	0	1	0	1	1	0	1	

2144 rows × 16 columns

```
# Importation d'une DS Extern

#https://simplemaps.com/data/us-zips

zipcode_data = pd.read_csv('/content/uszips.csv')[['state_id', 'zip', 'density']]
zipcode_data.dropna(subset=['density'], inplace=True)
print(zipcode_data.head(100))
```

```
    state_id  zip  density
0         PR  601    100.2
1         PR  602    477.6
2         PR  603    543.1
3         PR  606     47.3
4         PR  610    264.4
..       ...  ...      ...
101       PR  911   6028.4
102       PR  912   6474.9
103       PR  913   7984.8
104       PR  915   6743.9
105       PR  917   5151.5

[100 rows x 3 columns]
```

```
# Creation d'une DF Extern

state_density_df = zipcode_data.groupby('state_id').agg(
    zip_start=('zip', 'min'),
    zip_end=('zip', 'max'),
    new_density=('density', 'mean')
).reset_index()
state_density_df = state_density_df.sort_values(by='zip_start').reset_index(drop=True)
print(state_density_df)
```

```
   state_id  zip_start  zip_end  new_density
0        PR        601      987  1105.897710
```

```
1        MA      1001     2791  1218.233581
2        RI      2802     2921  1148.051852
3        NH      3031     3897   123.766802
4        ME      3901     4992    67.660798
5        VT      5001     5907    90.939623
6        CT      6001     6907   646.406597
7        NY      6390    14905  2141.604605
8        NJ      7001     8904  1532.152843
9        PA     15001    19611   533.255950
10       DE     19701    19980   564.182353
11       DC     20001    20591  3083.259649
12       VA     20105    24657   378.867996
13       MD     20601    21930   617.602516
14       WV     24701    26886    76.365718
15       NC     27006    28909   240.443611
16       SC     29001    29945   264.124292
17       GA     30002    39897   320.006933
18       FL     32003    34997   831.325519
19       AL     35004    36925   190.644512
20       TN     37010    38589   208.791667
21       MS     38601    39776    94.829508
22       KY     40003    42788   161.256923
23       OH     43001    45899   374.595377
24       IN     46001    47997   255.988971
25       MI     48001    49971   320.228730
26       IA     50001    52807    84.372062
27       WI     53001    54986   231.827075
28       MN     55001    56763   249.419410
29       SD     57001    57799    39.168800
30       ND     58001    58856    52.396649
31       MT     59001    59937    28.575068
32       IL     60002    62999   544.584670
33       MO     63005    65897   181.357874
34       KS     66002    67954   111.032244
35       NE     68001    69367   126.082765
36       LA     70001    71497   304.879406
37       AR     71601    72959    82.302602
38       OK     73001    74966   140.720934
39       TX     73960    79938   466.607387
40       CO     80002    81657   434.536243
41       WY     82001    83414    12.277654
42       ID     83201    83876    98.133692
43       UT     84001    84790   298.337584
44       AZ     85003    86556   517.472662
45       NM     87001    88439   107.021024
46       NV     89001    89883   655.026257
47       CA     90001    96161  1306.829079
48       HI     96701    96863   727.492784
49       OR     97001    97920   316.825761
50       WA     98001    99403   600.268595
51       AK     99501    99929    63.368980
```

```
# Creation des nouveaux Features

# Function to find state and density
def find_state_density(geo_code, state_density_df):
    if pd.isna(geo_code):
        return pd.Series([None, None])  # Return None for missing Geo_Code
    # Ensure the Geo_Code is numeric
    try:
        geo_code = int(geo_code)
    except ValueError:
        # Return None if Geo_Code is not numeric
        return pd.Series([None, None])
    # Filter the dataframe to find the matching row
    row = state_density_df[
        (state_density_df['zip_start'] <= geo_code) &
        (state_density_df['zip_end'] >= geo_code)
    ]
    if not row.empty:
        return pd.Series([row.iloc[0]['state_id'], row.iloc[0]['new_density']])
    else:
        return pd.Series([None, None])

if 'Geo_Code' in df_train.columns:
  # Apply the function to each Geo_Code
  df_train[['State', 'City_Density']] = df_train['Geo_Code'].apply(
      lambda x: find_state_density(x, state_density_df)
  )


if 'Geo_Code' in df_test.columns:
  # Apply the function to each Geo_Code
  df_test[['State', 'City_Density']] = df_test['Geo_Code'].apply(
      lambda x: find_state_density(x, state_density_df)
  )
```

```
df_train=df_train.drop(columns=["Geo_Code"])
df_test=df_test.drop(columns=["Geo_Code"])

display (df_train)
display (df_test)
```

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Small_Building	Medium_Building	Large_Bu
0	1.0	1	1	0	1	1	0	1	
1	1.0	0	1	0	1	1	0	1	
2	1.0	1	0	1	0	0	0	0	
3	0.5	0	1	0	1	1	1	0	
4	1.0	0	1	0	1	1	0	1	
...	...	...	...	...	...	...	...	...	
5007	1.0	0	1	0	1	1	1	0	
5008	0.5	0	0	1	0	0	0	1	
5009	1.0	1	0	1	0	0	1	0	
5010	0.5	0	0	1	0	0	1	0	
5011	1.0	1	0	0	1	1	1	0	

5008 rows × 17 columns

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Small_Building	Medium_Building	Large_Bu
0	1.0	0	0	0	1	1	0	0	
1	1.0	0	0	1	0	0	0	1	
2	1.0	1	0	1	0	0	0	0	
3	1.0	0	1	0	1	1	0	0	
4	0.5	0	0	1	0	0	0	0	
...	...	...	...	...	...	...	...	...	
2142	0.5	1	0	1	0	0	0	1	
2143	1.0	0	0	0	1	1	1	0	
2144	1.0	0	0	1	0	0	0	1	
2145	1.0	1	1	0	1	1	1	0	
2146	0.5	0	1	0	1	1	0	1	

2144 rows × 17 columns

```
#ordre des colunm

df_train=df_train.iloc[:, [0,1,2,3,4,5,6,7,8,9,10,11,12,13,15,16,14]]
display (df_train)
df_test=df_test.iloc[:, [0,1,2,3,4,5,6,7,8,9,10,11,12,13,15,16,14]]
display (df_test)
```

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Small_Building	Medium_Building	Large_Bu
0	1.0	1	1	0	1	1	0	1	
1	1.0	0	1	0	1	1	0	1	
2	1.0	1	0	1	0	0	0	0	
3	0.5	0	1	0	1	1	1	0	
4	1.0	0	1	0	1	1	0	1	
...	...	...	...	...	...	...	...	...	
5007	1.0	0	1	0	1	1	1	0	
5008	0.5	0	0	1	0	0	0	1	
5009	1.0	1	0	1	0	0	1	0	
5010	0.5	0	0	1	0	0	1	0	
5011	1.0	1	0	0	1	1	1	0	

5008 rows × 17 columns

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Small_Building	Medium_Building	Large_Bu
0	1.0	0	0	0	1	1	0	0	
1	1.0	0	0	1	0	0	0	1	
2	1.0	1	0	1	0	0	0	0	
3	1.0	0	1	0	1	1	0	0	
4	0.5	0	0	1	0	0	0	0	
...	...	...	...	...	...	...	...	...	
2142	0.5	1	0	1	0	0	0	1	
2143	1.0	0	0	0	1	1	1	0	
2144	1.0	0	0	1	0	0	0	1	
2145	1.0	1	1	0	1	1	1	0	
2146	0.5	0	1	0	1	1	0	1	

2144 rows × 17 columns

State

```
# Analyse

print("Nomber of None Values = ",df_train['State'].isna().sum())
display(df_train["State"].describe())

print("Nomber of None Values = ",df_test['State'].isna().sum())
display (df_test["State"].describe())
```

```
Nomber of None Values =  65
```

	State
count	4943
unique	37
top	NY
freq	705

dtype: object

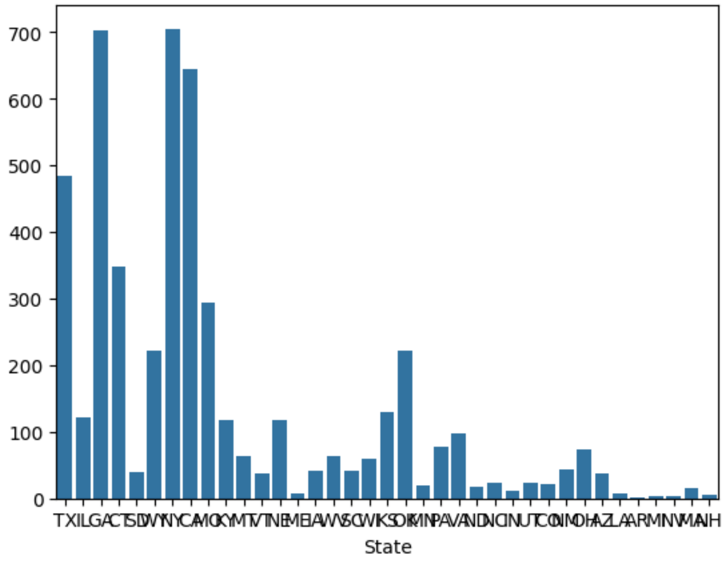
```
Nomber of None Values =  37
```

	State
count	2107
unique	37
top	NY
freq	336

dtype: object

```
# Visualisation

sns.countplot(x="State", data=df_train)
plt.ylabel("")
plt.show()
```




```
# traitement des valeur manquantes

df_train.dropna(subset=["State"],axis=0 , inplace=True,ignore_index=True)
display ( df_train)

df_test.dropna(subset=["State"],axis=0 , inplace=True,ignore_index=True)
display ( df_test)
```

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Small_Building	Medium_Building	Large_Bu
0	1.0	1	1	0	1	1	0	1	
1	1.0	0	1	0	1	1	0	1	
2	1.0	1	0	1	0	0	0	0	
3	0.5	0	1	0	1	1	1	0	
4	1.0	0	1	0	1	1	0	1	
...	...	...	...	...	...	...	...	...	
4938	1.0	0	1	0	1	1	1	0	
4939	0.5	0	0	1	0	0	0	1	
4940	1.0	1	0	1	0	0	1	0	
4941	0.5	0	0	1	0	0	1	0	
4942	1.0	1	0	0	1	1	1	0	

4943 rows × 17 columns

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Small_Building	Medium_Building	Large_Bu
0	1.0	0	0	0	1	1	0	0	
1	1.0	0	0	1	0	0	0	1	
2	1.0	1	0	1	0	0	0	0	
3	1.0	0	1	0	1	1	0	0	
4	0.5	0	0	1	0	0	0	0	
...	...	...	...	...	...	...	...	...	
2102	0.5	1	0	1	0	0	0	1	
2103	1.0	0	0	0	1	1	1	0	
2104	1.0	0	0	1	0	0	0	1	
2105	1.0	1	1	0	1	1	1	0	
2106	0.5	0	1	0	1	1	0	1	

2107 rows × 17 columns

```
# Label Encoading State
from sklearn.preprocessing import LabelEncoder
encoder = LabelEncoder()
df_train['State'] = encoder.fit_transform(df_train['State'])
df_test['State'] = encoder.fit_transform(df_test['State'])
```

City_Density

```
# Analyse

print("Nomber of None Values = ",df_train['City_Density'].isna().sum())
display(df_train["City_Density"].describe())

print("Nomber of None Values = ",df_test['City_Density'].isna().sum())
display (df_test["City_Density"].describe())
```

```
Nomber of None Values =  0
```

	City_Density
count	4943.000000
mean	699.039490
std	696.478626
min	12.277654
25%	181.357874
50%	378.867996
75%	1306.829079
max	2141.604605

dtype: float64

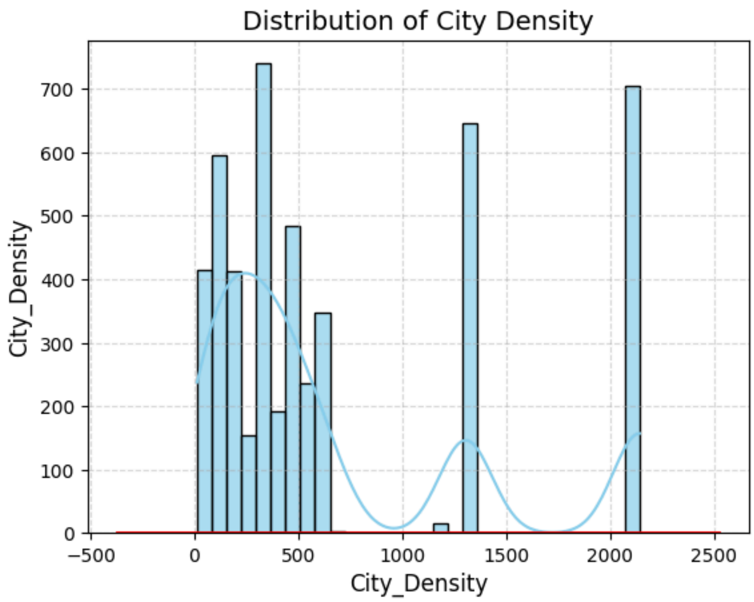
```
Nomber of None Values =  0
```

	City_Density
count	2107.000000
mean	731.164610
std	721.551011
min	12.277654
25%	181.357874
50%	466.607387
75%	1306.829079
max	2141.604605

dtype: float64

```
# Visualisation

sns.histplot(df_train["City_Density"], kde=True, bins=30, color='skyblue', edgecolor='black', alpha=0.7)
sns.kdeplot(df_train["City_Density"], bw_method='scott', bw_adjust=1, color='red', linewidth=2)
plt.title("Distribution of City Density", fontsize=14)
plt.xlabel("City_Density", fontsize=12)
plt.ylabel("City_Density", fontsize=12)
plt.grid(visible=True, linestyle='--', alpha=0.5)
plt.show()
```




```
#Astype

df_train ["City_Density"] = df_train["City_Density"].astype(int)
df_test ["City_Density"] = df_test["City_Density"].astype(int)

display(df_train)
display(df_test)
```

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Small_Building	Medium_Building	Large_Bu
0	1.0	1	1	0	1	1	0	1	
1	1.0	0	1	0	1	1	0	1	
2	1.0	1	0	1	0	0	0	0	
3	0.5	0	1	0	1	1	1	0	
4	1.0	0	1	0	1	1	0	1	
...	...	...	...	...	...	...	...	...	
4938	1.0	0	1	0	1	1	1	0	
4939	0.5	0	0	1	0	0	0	1	
4940	1.0	1	0	1	0	0	1	0	
4941	0.5	0	0	1	0	0	1	0	
4942	1.0	1	0	0	1	1	1	0	

4943 rows × 17 columns

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Small_Building	Medium_Building	Large_Bu
0	1.0	0	0	0	1	1	0	0	
1	1.0	0	0	1	0	0	0	1	
2	1.0	1	0	1	0	0	0	0	
3	1.0	0	1	0	1	1	0	0	
4	0.5	0	0	1	0	0	0	0	
...	...	...	...	...	...	...	...	...	
2102	0.5	1	0	1	0	0	0	1	
2103	1.0	0	0	0	1	1	1	0	
2104	1.0	0	0	1	0	0	0	1	
2105	1.0	1	1	0	1	1	1	0	
2106	0.5	0	1	0	1	1	0	1	

2107 rows × 17 columns

Claim

```
# Analyse

print("Nomber of None Values = ",df_train['Claim'].isna().sum())
display(df_train["Claim"].describe())

print("Nomber of None Values = ",df_test['Claim'].isna().sum())
display(df_test["Claim"].describe())
```

```
Nomber of None Values =  0
```

	Claim
count	4943
unique	2
top	non
freq	3837

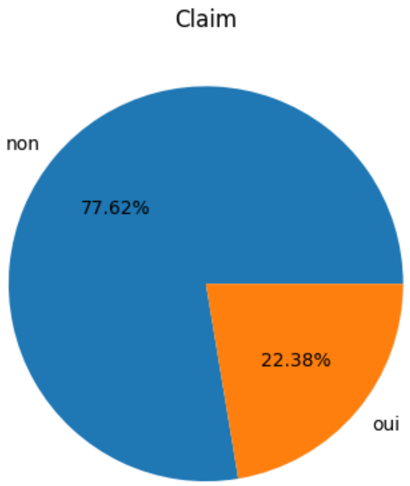
dtype: object

```
Nomber of None Values =  0
```

	Claim
count	2107
unique	2
top	non
freq	1608

dtype: object

```
# Visualisation
Claim_counts=df_train['Claim'].value_counts()
labels=list(Claim_counts.index)
df_train['Claim'].value_counts().plot.pie(autopct='%1.2f%%',ylabel="",labels=labels,title='Claim')
plt.show()
```




```
# Binary Encoding

#(oui : Claim , non : Not Claim)
df_train ["Claim"].replace({"oui":1,"non":0},inplace=True)
df_test ["Claim"].replace({"oui":1,"non":0},inplace=True)
#(1 : Claim , 0 : Not Claim)
display(df_train)
display(df_test)
```

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Small_Building	Medium_Building	Large_Bu
0	1.0	1	1	0	1	1	0	1	
1	1.0	0	1	0	1	1	0	1	
2	1.0	1	0	1	0	0	0	0	
3	0.5	0	1	0	1	1	1	0	
4	1.0	0	1	0	1	1	0	1	
...	...	...	...	...	...	...	...	...	
4938	1.0	0	1	0	1	1	1	0	
4939	0.5	0	0	1	0	0	0	1	
4940	1.0	1	0	1	0	0	1	0	
4941	0.5	0	0	1	0	0	1	0	
4942	1.0	1	0	0	1	1	1	0	

4943 rows × 17 columns

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Small_Building	Medium_Building	Large_Bu
0	1.0	0	0	0	1	1	0	0	
1	1.0	0	0	1	0	0	0	1	
2	1.0	1	0	1	0	0	0	0	
3	1.0	0	1	0	1	1	0	0	
4	0.5	0	0	1	0	0	0	0	
...	...	...	...	...	...	...	...	...	
2102	0.5	1	0	1	0	0	0	1	
2103	1.0	0	0	0	1	1	1	0	
2104	1.0	0	0	1	0	0	0	1	
2105	1.0	1	1	0	1	1	1	0	
2106	0.5	0	1	0	1	1	0	1	

2107 rows × 17 columns

```
# Label Encoading State
from sklearn.preprocessing import LabelEncoder
encoder = LabelEncoder()
df_train['State'] = encoder.fit_transform(df_train['State'])
df_test['State'] = encoder.fit_transform(df_test['State'])
```

Data Preprocessing (More Treatement)

```
# Traitement des duplicata (lignes)

duplicated_df_train = df_train[df_train.duplicated()]
display(duplicated_df_train)

duplicated_df_test = df_test[df_test.duplicated()]
display (duplicated_df_test)
```

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Small_Building	Medium_Building	Large_Bu
58	1.0	1	1	0	1	1	0	1	
87	1.0	0	0	0	1	1	1	0	
91	1.0	1	1	0	1	1	0	1	
103	1.0	1	1	0	1	1	0	1	
127	1.0	0	1	0	1	1	1	0	
...	...	...	...	...	...	...	...	...	
4937	0.5	0	1	0	1	1	1	0	
4938	1.0	0	1	0	1	1	1	0	
4939	0.5	0	0	1	0	0	0	1	
4940	1.0	1	0	1	0	0	1	0	
4941	0.5	0	0	1	0	0	1	0	

2819 rows × 17 columns

	Insured_Period	Residential	Building_Painted	Building_Fenced	Garden	urbain_zone	Small_Building	Medium_Building	Large_Bu
51	1.0	0	1	0	1	1	1	0	
58	1.0	0	1	0	1	1	1	0	
59	1.0	0	1	0	1	1	0	0	

```
df_train.drop_duplicates(inplace=True, ignore_index=True)
df_test.drop_duplicates(inplace=True, ignore_index=True)
```